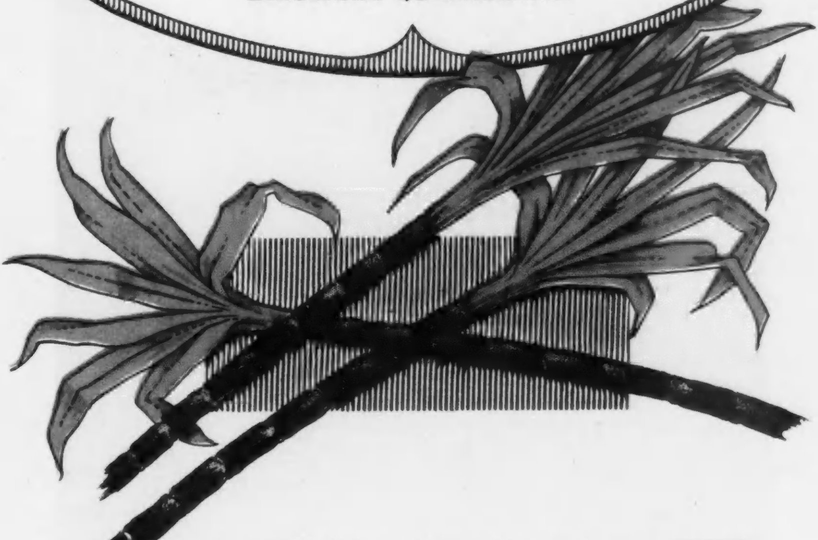
DEPARTMENT OF AGRICULTURE AND STOCK.

# The CANE GROWERS' QUARTERLY BULLETIN

ISSUED BY
BUREAU OF SUGAR EXPERIMENT STATIONS
BRISBANE, QUEENSLAND.



VOL. V. No. 4. 1 APRIL, 1938.

**Contents.**

BUREAU OF SUGAR EXPERIMENT STATIONS
BRISBANE

# THE CANE GROWERS' QUARTERLY BULLETIN

ISSUED BY DIRECTION OF THE
HON. F. W. BULCOCK, MINISTER
FOR AGRICULTURE AND STOCK

1 APRIL, 1938

DAVID WHYTE, GOVERNMENT PRINTER, BRISBANE

# CONTENTS.



* Reprinted by courtesy of the Queensland Society of Sugar Cane Technologists.

The

Cane Growers' Quarterly

—Bulletin—

VOL. V 1 APRIL, 1938 No. 4

# *The Farmer visits the Soil Chemist.

By H. W. KERR.

IT is unfortunate that the farmer is generally too busy ploughing, or harrowing, or destroying weeds, to be able to study the wonders of the soil with which he is occupied. But to-day, let us imagine that the farmer is taking a holiday from the farm, and is able to spend a brief hour or two in a visit to the soil chemist's laboratory, and see what the chemist can show him of the wonders of the soil. As it is not convenient for us all to visit the actual laboratory we have done the next best thing and have attempted to bring the laboratory to our meeting place.

Our first question is, what is soil? It is quite obviously composed of minerals of various kinds and sizes; and if we should visit a suitable road cutting, we can generally study the transition from surface soil, through various stages of decomposition, to the original unchanged rock. Furthermore, we notice that different rocks give rise to different kinds of soil; and these differences exist in respect both of appearance and agricultural value. It is apparent, then, that the parent rock has an important bearing on the question. Let us therefore examine the rock more closely and see what we can discover. We have before us two important soil-forming rocks of coastal Queensland: the first, a *granite,* which gives rise to large tracts of alluvial canelands in the far North; and the second, a sample of *basalt,* the parent rock of the well-known red volcanic loam of the Woongarra scrub lands.

Let us examine the granite. We do not even need a magnifying glass to show us that it is composed of at least three distinct types of substance "welded" together: firstly, we observe a greasy looking semi-transparent material, which we know to be *quartz*: secondly, a rather dull, white material, which is known as *feldspar*; and finally, a shiny black material, which we can flake off with a pen-knife, and which is called *mica.* We also have before us larger specimens of these three *minerals,* as they are known to the geologist, so that they can be studied with greater ease. On exposure, over many thousands of years, these apparently permanent and resistant minerals undergo changes due to seemingly insignificant but persistent forces of nature which act on all exposed rocks. In the first place, heating and cooling cause the mineral grains to expand and shrink repeatedly, and the rock is

* Address to the Q.S.S.C.T., Bundaberg Conference, 25th February, 1938.

caused to crack and shatter due to the different properties of the three minerals in this respect. The effects of rain and flowing water are to cause some of the minerals to change their character and turn into other minerals. In the case of quartz, we find that the only result of the weather—or *weathering* processes, as they are known—is to cause the larger grains to break up into smaller ones: these small grains are called sand, and they are identical with the sands which we find on the seashore and elsewhere. Our second mineral, the feldspar, does not withstand the weathering process nearly so well: for it changes into a new mineral called *kaolin*—which is a Chinese word—or to give it its popular name, pipe-clay, which we see here. In the process it loses certain of its original substance, and we shall see the importance of this in a few minutes time. The third mineral—the mica—does not rot away so rapidly as the feldspar, but is certainly not so permanent as the quartz: consequently, we often find mica flakes in a granite soil, but eventually they also lose their identity, to yield up some of their substance and give rise to further types of new mineral.

Consider now the manner in which our basalt rock behaves under the influence of the weather. This rock is totally different in its make-up from the granite we have just studied: firstly, it contains no quartz, and therefore a soil formed from basalt contains no sand grains; secondly, it is composed mainly of black minerals, which are not flaky like mica, but which in large masses look like the mineral specimens we see here; but it also contains feldspar minerals, though these differ somewhat in make-up from those existing in the granite. The main feature of the basalt is that it rots away much more readily than granite, and therefore the characteristic red volcanic soil which results is generally much deeper than the light-coloured sandy type of soil which exists in association with granite.

Now let us see if these soils exhibit any evidence of the processes which I have described, or resemblance to the rocks from which they have come. The chemist employs in his laboratory methods by which the soil can be separated into the individual grains, of different sizes, of which it is composed. Such methods have been applied to a granitic and a basaltic soil, with the result we see before us. (Fig. 27.) The granitic soil has quite a large proportion of sand grains, but also a reasonable amount of finer grains—called by the soil chemist "silt"—and finally, a percentage of still finer grains, known as "clay." Similar methods applied to the red volcanic soil show us that there is a small proportion of grains which are similar in size to the sand grains of the granitic soil, but these are grains of ironstone, and of the "rotting" products of basalt. The bulk of this soil, however, consists of silt and clay particles. The chemist will tell us, moreover, that these samples of sand, silt and clay from different soils are also very different in makeup, and these differences are very important in their influence on the fertility of the soil.

To make a long story short, the fact is that in the process of rock and mineral decay lies the clue to the value of the rock and the soil in nourishing our plants and crops: as minerals decompose we have seen that they give up portions of their substance, which can be dissolved in water: these we speak of as "plantfoods." And if the process of rotting which commences with the fresh rock minerals did not continue in the soil after it is formed, it would be quite incapable of supporting crops.

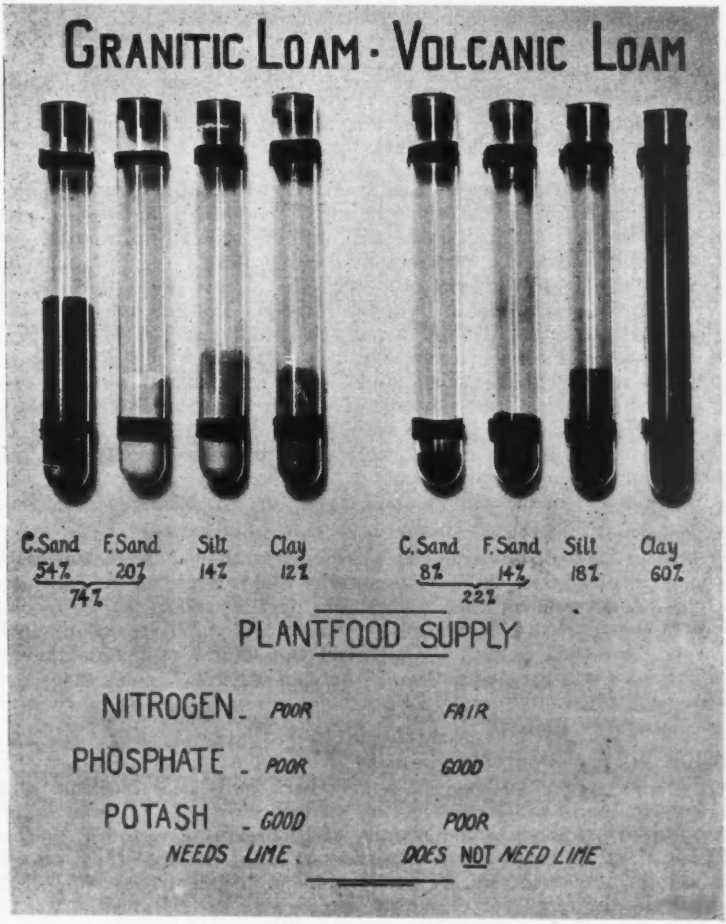



Fig. 27.—Chart showing the relative amounts of coarse sand, fine sand, silt and clay in—(*a*) Granitic loam and (*b*) Red Volcanic loam.

The manner in which the parent rock and soil-forming processes affect the plantfood supply is also shown.

Actually, there are six such distinct mineral plantfoods which result from mineral decomposition and which are essential to crop growth: one of these is *potash*, which is yielded by some of the feldspars and mica: *calcium* (or more familiarly, lime) is yielded by other feldspars: *iron* comes largely from the black coloured rock minerals, in which we saw the basalt was so rich; and so on for the other plantfoods—*phosphate*, *magnesium* and *sulphur*, which make up the six.

It should now be quite a simple matter to understand why it is that certain soils contain different proportions of the individual plantfoods. Thus basalt rots readily, and as it contains several minerals rich

in lime and but few yielding potash, it usually gives a soil well supplied with lime but poor in potash. Granite, on the other hand, contains few lime-bearing minerals, but has quite a liberal supply of potash-yielding substances. It therefore is likely to give us a soil rich in potash, but probably lacking in lime. Later our chemist will carry out tests for us which will show that this is actually the case.

When the farmer grasps this truth, he will realise why it is that some soils do not yield the crops he might reasonably anticipate, even though he has cultivated the land well, and the rainfall distribution has not been unfavourable. The secret probably lies in the fact that the soil is not able to provide the crop with the correct proportions of the individual plantfoods, and it is in the farmer's interests to supplement any deficiency of supply. This introduces us to the subject of fertilizers and their use. Fertilizers are simply substances which contain soil plantfoods in concentrated form, and a small amount applied to the soil provides a relatively large quantity of plantfood in such a form that it can readily be absorbed by the crop roots. But the farmer must be careful that he uses the correct balance of plantfoods which the soil demands, or he may be piling potash on to a soil already rich in that plantfood, while neglecting the phosphate for which the crop may be starving.

The business of advising the farmer as to the food deficiencies of his land is, of course, the business of the Sugar Experiment Stations. First of all our officers must find out by fertility trials, conducted on the farms, the nature of the plantfood supply characteristic of each soil type, and then base their advice on the results actually obtained. You are all acquainted with these trials and the conclusions which are drawn from them: they are summarised each year in the January issue of the Quarterly Bulletin.

But the project of farm fertility trials is altogether too slow and laborious to enable the Bureau to give each individual block of each canegrower the specialised attention that is desirable. It was therefore necessary to devise other simpler and more rapid methods for this purpose, if at all possible. After many years of patient study we are now able to announce that we possess proven chemical tests which can be made in the laboratory, and which agree in their indications with what we actually find from farm trials. We will now call upon our chemist to demonstrate to us how he tests a soil to determine whether it is lacking in phosphate or potash (or both): while he is preparing the material for these tests, I will explain also another test which is always made on all samples received. The farmer is generally acquainted with the importance of applying lime to those soils which are sour, in order to improve their quality for crop production. Now whereas a modest lime application would never be harmful to any Queensland cane soil, it is obviously uneconomical, if not wasteful, to apply lime to soils which do not require it. We have therefore devised a very simple test which will also be demonstrated to show how we find out whether soils are sour or not. We ask our farmer friends to note carefully what we mean by "sour" soils; we refer to soils formed from rocks poorly supplied with lime, and which under conditions of high rainfall readily lose their supply; and in consequence the soil acids so released are so strong as to be harmful to the crop roots. There is another class of soil,

usually clayey in nature, which is wet and lacking in "sweetness," and which is frequently very difficult to cultivate; such soils, we know, are often improved in character by the addition of lime. But the lime in this case is for quite another purpose than neutralizing soil acids, and the farmer should formulate his own judgment in this respect; our acidity tests have no direct bearing on this phase of the problem.

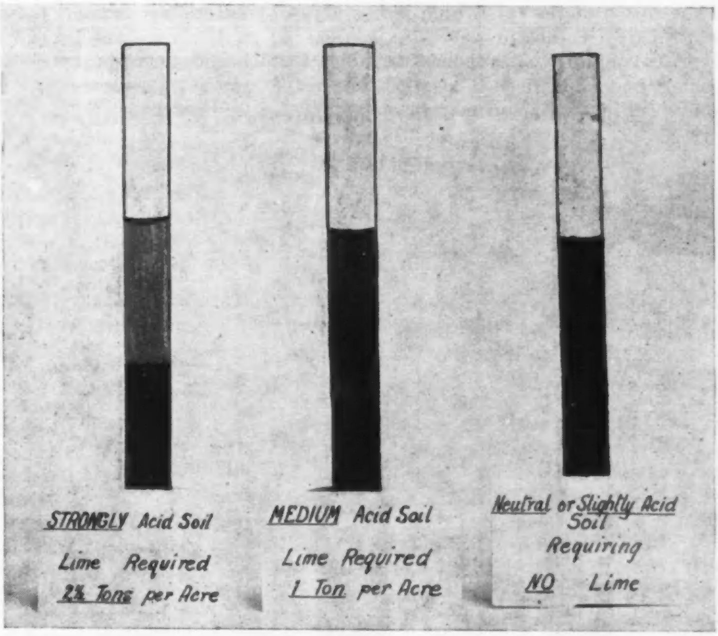



Fig. 28.—Illustrating the Soil Acidity Test. The *yellow* colour of the dye solution, in the left-hand tube, showed strong acidity and the need for heavy liming; the central tube indicated medium acidity, by showing a *green* colour; while that on the right showed a strong *blue* colour, which means that no lime is required.

So far I have purposely refrained from mentioning a seventh plant-food material which is of very great importance to Queensland canegrowers. This is *nitrogen*, which comes not from the soil minerals, but from that portion of the soil which is derived from quite a different origin. From what has been discussed hitherto, one might imagine that the soil is simply a mixture of decomposed and undecomposed minerals, which are quite lifeless and inert. Actually this is far from the truth: for the soil is the inevitable receptacle for the vegetable remains of the entire plant life which it supports, and for the residues of the animal life which dwells on and in it. Such materials—known as organic matter—are also the natural food materials of the myriads of minute life—known as bacteria and fungi—which consequently occupy the soil as their natural habitat. Thus we have in the soil very distinct constituents which invest the soil with life, and which are composed of the by-products of life processes. One of these is our valuable plantfood

nitrogen. No plant or animal can exist without a supply of nitrogen, which it builds into its tissues. After it has perished, the nitrogen is once again converted, through the agency of minute soil organisms, to a state in which it is again available for further plant growth. That fraction of the soil which comprises the decomposed vegetable and animal remains is called by the soil scientist *humus,* and is one of the most important constituents of the soil from many points of view. This is one phase of the soil which is not very obvious to the farmer, though he probably is aware of its existence. A well decomposed mass of farmyard manure approaches very closely to humus in appearance and properties. But we will also ask our soil chemist to show us how the humus content of a soil may be demonstrated. (Fig. 29.)

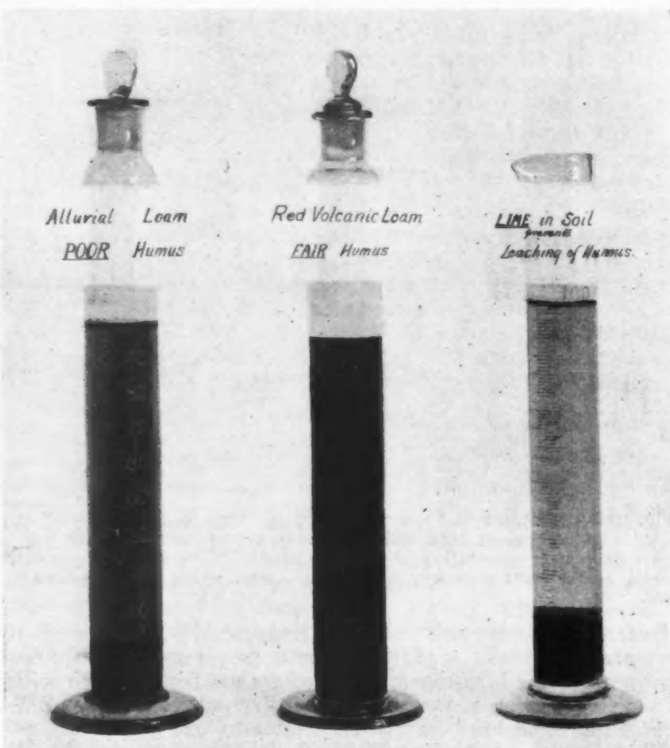



Fig. 29.—Illustrating the Humus Test. The depth of colour of the liquid is a guide to the humus content of the soil; the alluvial loam is thus seen to contain less humus than the red volcanic loam. To the tube on the right, burnt lime was added; this completely removed the humus, to give a dark sediment and a clear water layer. In the soil, lime is thus instrumental in preventing the leaching of humus.

In general, the more humus the soil contains, the better is its supply of nitrogen for the purposes of plant nutrition. But unfortunately those soil conditions of high temperature and abundant

moisture, which make for rapid cane growth, are just those conditions which make also for rapid decomposition and loss of humus from the land. Hence it is that our cane soils require a supplement of available nitrogen, if they are to continue to produce profitable crops. This may be applied in the form of dried blood or meatworks offal, or as sulphate of ammonia and nitrate of soda. But such a policy is costly, and moreover, there are at the disposal of the farmer other and cheaper methods by which this process may be achieved, at least to some extent, while conferring other benefits on the soil as well. But I will leave it to Mr. Bell to expand the details of this very interesting and important question. (See p. 138.)

So we finalise a rather hurried discussion of soil forming processes and their relationship to crop growth. But in addition to food, the crop must also have water, as Bundaberg canegrowers are all too frequently reminded, in the many drought periods which they experience. With your permission, I will therefore discuss briefly this phase of plant nutrition, and attempt to indicate those features of the soil which bear on the question.

It is a well-known fact that crops on clayey soils withstand droughty spells to much better advantage than do those on sandy loams. Why is this?

To provide the full story, we must go back to the constituent particles of our soil. We have seen that a sandy soil—such as is usually obtained from a granite rock—is rather rich in coarse sand particles and poor in the finer silt and clay portions. Now when a soil is wetted, the water does not actually pass "into" the soil: what really happens is that a fine film of water is formed around each of the individual grains of soil, whether they be large or small; and the quantity of water which a soil holds when wetted is largely a measure of the total area of all the surfaces of all the individual grains of the soil. To illustrate this point more clearly, suppose we take a piece of basalt rock in the form of a cube, 1 cubic inch in volume. It is seen that the surface area of such a cube is 6 square inches. If this be dipped into water and allowed to drain it is obvious that the piece of rock has merely become wetted on the surface and is not "saturated" with water. If we could now split our cube into eight smaller cubes, each ½ inch on the side, we will have increased the total surface area from 6 to 12 square inches; for the surface area of each of the small cubes is 1½ square inches, and there are eight such cubes. The surfaces of the smaller cubes will therefore retain, on wetting, twice as much water as the original cube. As we subdivide the cubes still further, the surface area of the original piece of rock becomes greater and greater: and it has been calculated that the total surface of a weight of clay particles, equal to that of the original inch cube of basalt, would actually be some hundreds of square yards. It would therefore appear that the greater the proportion of fine particles in a given weight of soil, the greater will be its capacity to take up and retain water during periods of rainfall, or when irrigation water is applied. This is indeed the case, as our chemist will now demonstrate. (Fig. 30.)

Again our story would not be complete if we were not to stress once more the importance of soil humus or organic matter in this connection. Whereas, in a well-drained soil, sand can hold in the form of surface

films about one-seventh of its weight of moisture, silt will hold one-quarter, and clay about one-half: but humus possesses the virtue of retaining almost *twice* its weight of moisture, to be made available to the growing crop in dry times. And so we can understand why even the modest 3 or 4 per cent. of humus which a good soil contains is so important also from the point of view of the moisture holding capacity of the soil.

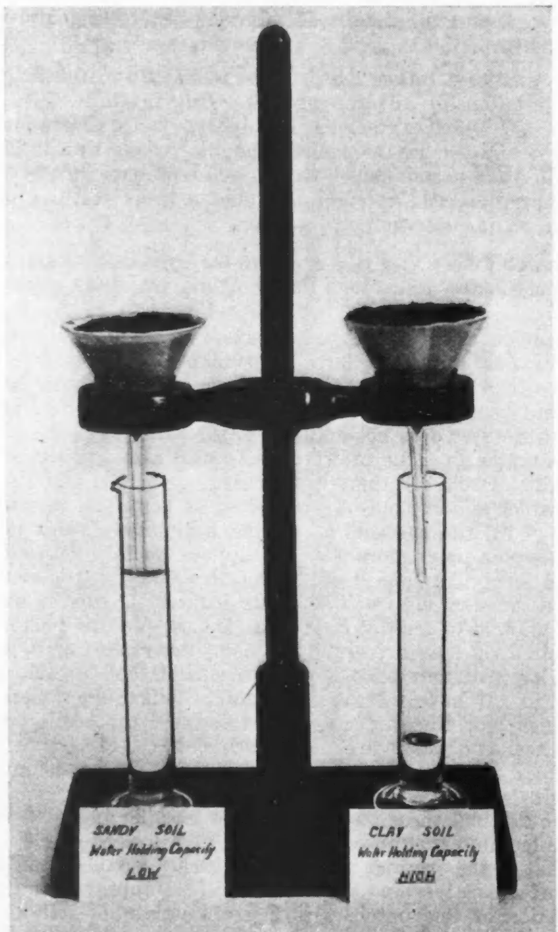



Fig. 30.—Illustrating the influence of soil type on Water Holding Capacity. Equal weights of soil received equal volumes of water; it will be observed that whereas there was little surplus for drainage, with the clay soil, there was a substantial excess with the sandy soil.

Clay soils therefore hold more moisture and are more drought-resistant than sandy soils.

Finally we should point out that the individual soil grains—whether sand, silt, clay or humus—do not exist simply as a mechanical mixture, in a good agricultural soil. This condition does indeed exist in some soils which are difficult to cultivate, and when an attempt is made to bring them to a condition of good tilth, they become as fine as dust: when wetted they run together, and on drying once more become compacted to a concrete-like mass. But a first class agricultural soil is found to consist of an aggregation of small irregular crumbs which readily separate one from another when at the most desirable condition of moistness; these crumbs or granules actually consist of loose aggregates of soil grains of all dimensions, in which the sand and silt particles form a matrix which is loosely bound together by the very fine clay and humus particles. Again the humus is most important in maintaining this desirable condition in the soil. The process of intensive cultivation with implements, on the other hand, tends to destroy the granules, and the process of ploughing a soil when too wet readily provides merely an exaggerated effect of this influence.

In conclusion, let us briefly summarise what we have learned from our visit to the soil chemist's laboratory. We saw that soils were the products of rock disintegration and decomposition, whereby many of the original minerals are slowly changed to new forms, and plantfoods are liberated in the process. We learned also that different rocks decompose at different rates—some giving shallow and some deep soils. Moreover, the kinds and amounts of plant-foods yielded by any rock depended very much on the kind of minerals contained in the parent rock: and while a soil of one origin might give just the supply of plantfoods which our particular crop desires, others do not provide the "balanced diet," and the farmer must take a hand in supplementing any nutrient deficiencies, by the use of a suitable fertilizer mixture. With soils from high rainfall areas the chemist showed us that the lime is often washed away just as quickly as it is released by mineral decomposition, and under these conditions the farmer must supply lime to correct the objectionable and harmful acids which are thus produced. The chemist has also shown us the methods he employs to provide him with the intimate details of the chemical conditions of the soil.

Then we were given a demonstration of the presence of the black waxy substance present in all soils, in greater or less amounts, which we called Humus. We learned that humus is the sole source of that important plantfood nitrogen, so essential for vigorous crop growth, and so generally deficient in amount in our Queensland soil, because of the great rate at which heat and moisture combined with intensive cultivation, cause it to decompose.

And lastly, we were shown how the amount of moisture which a soil will hold after rain is governed by the coarseness or fineness of the individual mineral grains of which the soil is composed, and above all, the value of the sponge-like organic matter or humus in its ability to hold moisture.

So we come to the end of our brief excursion into the realms of soil science, though we have done nothing more than visit the outskirts. I can only wish it were practicable to venture more boldly with you and discover more of the inner secrets of the wonderful thing which we call soil, and which is the foundation of every phase of life and civilization.

# A Note on Fodder Crop Experiments at Meringa Station.

THE provision of suitable fodder for farm animals constitutes an ever-present problem for the cane grower, outside the crushing season and also towards the end of the season, when chop chop is scarce as a result of a large proportion of the cane crop being burnt prior to harvesting. Some growers try to provide off-season fodder by allowing their old ratoons to volunteer until sufficient cane and top is produced for chop chop purposes, after which the old stools are hurriedly ploughed out and the block replanted. This practice has many disadvantages inasmuch as diseases may be carried over to infect the next year's crop; pests are subjected to little or no check, and the growth of a green manure crop is prevented. These facts have impressed us with the desirability of farmers setting aside a small acreage for the growing of fodder crops and it was deemed desirable to initiate some experiments along these lines at the Meringa Station.

Considerations of disease control decree that there should not be grown on a cane farm any crops which are closely related to sugar cane and which might act as hosts and sources of infection of diseases of sugar cane, or the insects which spread them. For this reason therefore, maize and sorghums should be excluded. Our experimental programme is only in its infancy, but it is thought that even the very early results may be of interest to farmers.

Fig. 31.—Soybean, variety Ototan, eight weeks after sowing. The soybeans were sown in drills 3 feet apart and 6 inches deep, but only a light covering of soil was given. (Note:—The row of soybean to the right is of another variety.)

Fig. 32.—*Panicum coloratum* ready for harvest. This grass was grown from seed planted in very shallow drills some 3 feet apart.

Trial sowings have been made with panicums and digitarias (obtained through the courtesy of the Bureau of Tropical Agriculture), soybeans, lespedezas and clovers. To date none of the tested varieties of lespedeza and clover have performed satisfactorily. Soybeans, especially the variety Otootan, show some promise, and selected varieties will be given further trial with monthly plantings. In Fig. 31 is reproduced a photograph of the variety Otootan taken eight weeks after sowing; the crop was then some 2 feet 6 inches to 3 feet high and still making growth. This particular variety is widely used overseas for hay production; the other varieties are not so vigorous but are worth consideration as seed producers.

Two digitarias (valida and Pole-Evansii) were planted from root clumps. These grasses send out runners which take root and later form a continuous mat of grass. Under Meringa conditions valida appears superior to Pole-Evansii, but neither grew well during the dry spring weather; their stems became hard and were difficult to chaff. Both have rather thin coverage and allow the growth of other grasses and weeds. In addition the type of rooting might be such as to cause trouble in subsequent cultivation of other crops and they may possibly prove better for grazing than for hay purposes.

Panicums comprised *Panicum coloratum, Panicum maximum* (fine stemmed Guinea grass, and *Echinochloa crus-galli* (white panicum). The fine stemmed guinea grass is reputed to have made good growth at South Johnstone, but owing to the small amount of roots available it has been necessary continuously to subdivide our stocks for further propagation. Consequently we are unable to furnish much information

regarding its growth and palatability. However, its reputation is good and it is being extensively propagated on the Tableland and the Daintree.

Coloratum is reputed to give rather indifferent germination but our first sowing (under irrigated conditions) gave excellent results in August; midsummer sowings under natural rainfall conditions did not germinate nearly so well and some portions had to be re-seeded. This grass did well under average rainfall conditions, and horses readily eat it. The first cutting (see Fig. 32) was made on 20th December, and in a month's time the ratoons had grown to a height of 2 feet 9 inches and commenced to flower again. A second cutting of a portion was then made, but heavy rains fell immediately afterwards and grass clumps rotted badly and ratoons came away sparsely. The remaining portion of the plot received the second cutting about a week later, but on this occasion it was cut higher (about 9 inches from the ground) and the ratooning greatly improved. Additional plots of this grass, planted towards the end of December, commenced to flower in mid-February.

Fig. 33.—White Panicum, seven to eight weeks old. Seed sown in very shallow drills 3 feet apart.

White panicum is a very promising grass under Meringa conditions. Its rapid growth, high fodder value, and the readiness with which stock will eat it strongly suggest that it should be a valuable summer fodder crop for North Queensland coastal conditions. The seed germinated well, the young plants quickly became established and choked out any foreign weeds. One crop, planted towards the end of December, grew 4 feet to 4 feet 6 inches in seven to eight weeks (see Fig. 33). It is a prolific seeder and if the crop is not cut before the seeds mature they will germinate later and possibly compete seriously with other crops (if any) later planted on the same land.

## Fertilizer "Burn."

A severe case of fertilizer burn has been brought to our notice in the Mulgrave area, where a field of D.1135 failed to germinate and had to be ploughed out and replanted. The damage can be attributed directly to the method of application rather than to the type of fertilizer used. In planting, a combined driller, planter, and fertilizer machine was used, the fertilizer being dropped immediately on top of the plant. The result was that the young, tender roots were burnt and the set failed to grow.

The Bureau has always recommended placing fertilizer in the drill with the plants, but at the same time advises this to be put in the bottom of the drill and under the plant.

It is not suggested that applying fertilizer on top of the plant will always cause trouble, but nevertheless it has been proved that under certain conditions a complete failure in germination may result. In the case under review only 4 cwt. of fertilizer per acre was applied, and while soil moisture was ideal at the time of planting, dry conditions followed. The rows without fertilizer gave almost 100 per cent. "strike."

G.B.

## Molasses for Fattening Lambs.

In a recent publication received from the State of Washington, U.S.A., are interesting details of an experiment to determine the value of beet molasses as a feed for lambs. The molasses, which was fed in quantities varying from ½ to 1 lb. per lamb daily, was diluted with three parts of water and poured over the solid feed of maize and hay.

From the data obtained it is calculated that 2,000 lb. of beet molasses are equal in feed value to 1,704 lb. of maize and 978 lb. of hay. The market grade of the lambs fed various rations showed that those which received supplementary molasses were very little inferior to those which were fed maize only, and it was concluded that the value of the two feeds was dependent upon the relative price of maize and molasses.

Under Queensland conditions molasses in the coastal areas would be by far the cheaper feed, and the possibilities of this by-product in supplementing the ration of fattening lambs is evident.

H.W.K.

# *Crop Rotation, with Special Reference to the Principles of Green Manuring.

By A. F. Bell.

IT is proposed in this lecture to discuss in general terms the subject of crop rotation, paying particular attention to the scientific principles involved in that form of crop rotation which is known colloquially as "green manuring."

It is an axiom of agricultural science that continuous cropping to the one crop is likely to be one of the worst possible practices of husbandry. And particularly is this to be condemned when the crop in question is one which requires constant and intensive cultivation as is the case with maize and sugar-cane. When opening the conference in Cairns last year the Minister for Agriculture drew attention to certain undesirable trends in the direction of soil erosion and impoverishment and made a plea for balanced agriculture.

At the conference held in Bundaberg in 1935 I submitted a paper entitled "Sick Soils," and at this stage we will review briefly some of the points presented in that paper:

It is a significant fact that the permanent agricultural systems of the old world, with their centuries of experience, are all built upon well-planned programmes of crop rotation. Such programmes usually involve about a five-year cycle, any particular crop appearing not more than twice in the cycle, while the succession is planned so that a particular crop plant is not followed by one of similar habit, type, diseases, and method of cultivation. Thus in a planned rotation corn would not follow sugar-cane and *vice versa.*

What then, one may now ask, are the unhappy results which may follow continuous cropping to a crop plant which requires constant and intensive cultivation. The answer is that under such conditions as prevail in these dry, unirrigated areas the soil will suffer a gradual but remorseless loss of fertility while at the same time it develops a chronic "sickness."

During the 40-year period from 1898 to 1937 the average yields of sugar-cane in tons per acre in the Bundaberg-Gin Gin district have been as follows:—

| 1898-1907 | 1908-1917 | 1918-1927 | 1928-1937 |
|---|---|---|---|
| 14·6 | 15·3 | 14·4 | 15·9 |

During this period much new land has been brought under cultivation, the use of artificial fertilizers has developed from nothing to a highly important farm practice, while new and better varieties have been grown. Yet the yield of cane has barely held its own, and one might well ask why it has not progressed.

In an exhaustive analysis of rainfall data made by Mr. Norman King and published in the "Canegrowers' Quarterly Bulletin" for October, 1936, we find that (many opinions to the contrary) the seasons

* Address to the Q.S.S.C.T., Bundaberg Conference, 25th February, 1938.

have not changed; the average annual rainfall has been maintained. Obviously, then, the explanation of this static position must lie in a gradual loss of the inherent fertility of the soil, which is balanced by improved varieties and otherwise improved farm practice.

Now it has so happened, through the fortunate foresight of one of the old pioneers of the Woongarra, that there was left standing a patch of the original virgin scrub. Some few years ago we carried out comparative tests on this virgin soil and a field immediately adjacent which had been cultivated for twenty-two years. Of course, a great deal of this land has now been cultivated for over fifty years, and a comparison with this would without doubt be even more depressing, but it is bad enough as it is. Figures observed from some of the tests were as follows:—

| | Virgin Soil. | Adjacent 22 years cultivated. |
|---|---|---|
| Moisture Equivalent* | 38% | 30% |
| Organic Matter (or Humus) | 7·8% | 3·6% |
| Nitrogen | 0·48% | 0·22% |

In short, the native fertility is being rapidly lost as a result of growing continuously a crop which is a gross feeder and which requires that constant cultivation which brings about fertility depletion and soil erosion; the soil is becoming "dead."

We pass now to another side of the picture—the development of a "sick" condition of soil. The normal fertile soil literally teems with countless numbers of minute, invisible plants known as bacteria and fungi; they are so small that 15,000 or 20,000 bacteria laid out end to end would only stretch about an inch. These lowly microscopic plants include both benefactors and enemies of the plants we cultivate. The great majority, fortunately, have a beneficial effect or at least do no harm; they are concerned in the decay and rotting of vegetation, making the enclosed plant-foods available to the growing crop, assisting in the weathering of the soil, converting nitrogen to forms suitable for the plant, and so on. Generally speaking, the more fertile the soil the greater will be the numbers of these beneficial and harmless little organisms.

It is possible to count these organisms with reasonable accuracy by means of a very simple process: A small amount of the particular soil under investigation is taken and gently shaken with a measured quantity of water so that the bacteria and fungi become evenly distributed through the water. A known fraction of the watery suspension is then drawn off and mixed with a substance known as nutrient agar. This agar is poured into a glass plate, where it solidifies like gelatine and, in the course of a few days, the bacteria and fungi multiply, and each forms a colony which later becomes visible to the naked eye. We are then able to count the numbers poured into the plate, and so, by multiplication, the numbers in the amount of soil taken. Such numbers

* This soil contains a high proportion of so-called "hygroscopic" moisture which is not available to the plant; therefore about 20 per cent. should be subtracted in each case, giving *effective* moisture-holding capacities of 18 and 10 per cent.—a decline of nearly 50 per cent. Small wonder then that cane on these soils now commences to show distress a fortnight after good rain. Similarly the humus, nitrogen, and other plant foods have declined to low levels.

are usually given as the numbers per gram of soil—an amount equal to about a quarter of a teaspoonful of soil.

We made counts of this type on two soils which were separated by only a headland, but, while one farmer has allowed his soil to run down and become dead, the other has consistently practised trash conservation and green manuring for many years, and so has largely maintained the fertility of the soil. The counts were—

*Organisms per gram of soil.*

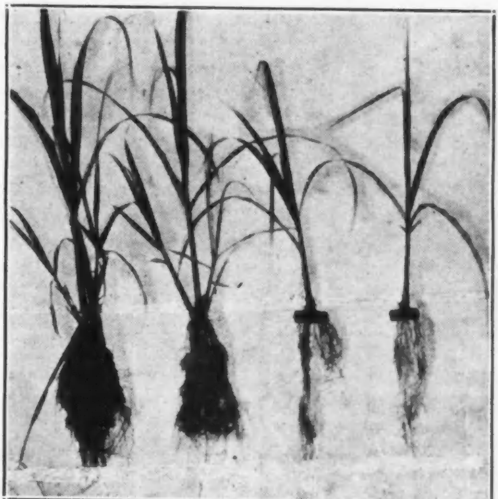
| | Bacteria. | Fungi. | Total. |
|---|---|---|---|
| Fertile Soil .. .. | 16,800,000 .. | 2,200,000 .. | 19,000,000 |
| Worn-out Soil .. .. | 3,100,000 .. | 50,000 .. | 3,150,000 |

But in addition to these beneficial and harmless bacteria and fungi the soil contains parasites which attack the roots of the plant, and the less beneficial or harmless organisms there are the better chance the parasites have. Now, soil which is virgin soil in so far as a particular type of crop is concerned will contain few, if any, parasites which will attack it. However, as successive plantings of a particular crop are made, so do the parasites which will attack it increase in numbers, and ultimately are present in sufficient numbers to distress the plant and stunt its growth. Many root parasites will attack a large number of closely related plants, and the planting of corn, for example, in "sick" cane land will only serve to further increase those parasites which attack members of the grass family generally. On the other hand, during the period of continuous planting to sugar-cane, the parasites which might attack, say, a legume are left without a host, and so they diminish greatly in numbers and may even become extinct.

This, then, is a basic point in the planning of rotational programmes. No one plant is left in the ground long enough for its particular parasites to build up in great numbers; it is displaced by a second crop plant, and the numbers have diminished before the first crop is returned to the soil again.

That a condition of soil sickness has been brought about in at least some of our older cane lands will be readily appreciated by reference to Fig. 34. In this case cane was grown in "sick" soil and in soil which had been "cured," so to speak, by sterilizing. As can be seen, the sick condition of the soil has caused a very marked loss of vigour as a result of root rot.

The agricultural phase of the Queensland cane-sugar industry is based upon the practice of continuous cropping to this one crop, a crop which, moreover, requires extensive cultivation and which has little protective influence on the soil. We say continuous cropping because a possible green-manure crop every four years cannot be regarded as crop rotation. The time has come when the trends resulting from this unfortunate combination of circumstances must be recognised and faced, even though farmers do not control two important factors which have largely determined the adoption of this practice. These are (*a*) the almost complete absence of payable alternate crops and (*b*) the existing system of cane land assignment, whereby a farmer must restrict cane production to a certain certified area, precludes the adoption of a rotational programme if a farmer is growing up to his full assignment.



1. 2. 3. 4.

Fig. 34.—Reading left to right—(1) Sterilized soil, (2) Sterilized soil, (3) 75 per cent. Sterilized soil, 25 per cent. unsterilized soil, (4) Unsterilized soil. Variety—Q. 813. Note failure of cane to stool in 3 and 4.

It does not appear probable that there will be developed in the near future any extensive production of alternate crops which can be marketed as such, although there does seem to be some scope for the utilization of land for intensive grazing and fodder production. In this connection we might make passing reference to the very successful experiment in lucerne production at the Bundaberg Station and the interesting fat lamb raising experiment which is being carried out at the Mackay Station.

There is, however, another aspect of crop rotation which warrants your consideration and attention, and that is rotation to crops which may not in themselves be directly payable propositions, but which will help to restore the fertility of the land to such a level that the same amount of cane may be grown more profitably on a reduced area of land. We have in progress at the Bundaberg Station a long-range experiment which will test the economics of this proposition over a number of years within the limitations of the assignment system. In this experiment part of the field will be cropped according to usual practice, that is, we will take off a plant and two ratoon crops, the second ratoon crop being harvested at the end of the season, ploughed out, and prepared for planting in the following autumn. In the other portion of the field a plant and one ratoon crop only will be taken off, and the field will then be planted to a succession of leguminous crops for a period of sixteen months. We are now carrying out trials to find additional legumes which will be suitable for this type of rotation, including types which may be either ploughed in or grazed if the occasion warrants.

The reason for the advocacy of legumes as a rotational crop is twofold. Firstly, they are very widely removed from sugar-cane in so far as plant relationships are concerned, and it therefore follows that

parasites of legumes are most unlikely to attack sugar-cane and *vice versa*; therefore a prolonged period of cropping to legumes will see a vast reduction in the ranks of the army of sugar-cane parasites. Secondly, a legume possesses the peculiar power of obtaining its nitrogen requirements from the nitrogen of the air instead of drawing them from the soil, as do other plants. Consequently, when a leguminous crop is ploughed into the soil, the soil may be enriched in nitrogen to an amount equivalent to a substantial dressing of sulphate of ammonia, but for which no account will be rendered at the end of the month. The explanation of the manner in which this free nitrogen supply is obtained will constitute the second part of the talk.

It has long been recognised by farmers that the growth of leguminous crops tends to enrich the soil. Later it was found that this was due to the fact that in some way or another these plants could actually add to the store of nitrogen in the soil. Consequently legumes came to be more and more used as rotational crops, particularly when soils showed a tendency to become run down, or immediately preceding the growth of a crop which needed large amounts of nitrogen for its proper growth. Trial and experience showed that it often happened that a particular legume would not grow when planted in fields which had never grown legumes or had not been planted to them for a long time. In other cases a variety which did well in one part of the world was for some unexplainable reason practically a complete failure when taken to another country with a similar climate. Observant farmers had, however, discovered the fact that they could often improve yields in a new field by "inoculating" it with a few loads of soil taken from a field in which the particular crop grew well; doubtless many of you have seen this practised by old lucerne growers.

Investigation of these phenomena by trained agriculturists has removed the veil of mystery, and we are now able to present a pretty clear picture of why and how legumes assist in the regeneration of soil, why there are fluctuations in growth, and why there may be almost complete failures.

Leguminous crops planted in a soil rich in nitrates and other plant-foods will grow vigorously in the same way as do other crops. It so happens, however, that, unlike other crops, they would also grow vigorously, and possibly even more satisfactorily, if the same soil were very deficient in nitrates. The reason for this somewhat contradictory performance lies in the fact that leguminous plants, in association with a certain type of bacterium, can draw their supplies of nitrogen from the atmosphere instead of being forced to take it in the form of soil nitrates as is the case with other plants.

As you know, some four-fifths of the atmosphere in which we live is composed of nitrogen, and, of course, this atmosphere diffuses into the soil, so that in a well-aerated soil there is always atmospheric nitrogen in contact with plant roots. This atmospheric nitrogen, however, exists in the form of an inert gas, and in that form it cannot be absorbed and utilised by man, animals, or crop plants. It may, however, be "fixed" and converted into forms suitable for such use, and in various overseas countries there are vast works for capturing this nitrogen and converting it into the sulphate of ammonia which you

apply to the soil, and which is converted into nitrates in the soil. As suggested above, it may also be captured and converted into suitable forms by legumes working in association with bacteria.

Upon digging up a legume and washing the roots free of soil, it will be noticed that in most cases there are small galls or nodules attached to the roots. These nodules represent the tiny workshops within which the fixation and conversion of the nitrogen of the air is carried out by bacteria of the genus *Rhizobium*. The relationship is a mutual benefit society, since the plant supplies the bacteria with free board and lodging, while the bacteria, on the other hand, help the plant to free supplies of nitrogen. This nitrogen is not stored in the nodules, as many people seem to think, but is immediately distributed over the rest of the plant for use in making new growth.

In Fig. 35 are reproduced the root systems of two soybean plants, and attached to the main roots of these will be seen a cluster of these galls or nodules. Countless numbers of bacteria exist within the nodule; they are small, rod-like creatures about $\frac{1}{10000}$ – $\frac{1}{15000}$ inch long (*see* Fig. 36). These bacteria may readily be grown or cultured in the laboratory in tubes of agar or gelatine, where they form a yellowish-white glistening, slightly raised growth. In this condition they cannot use atmospheric nitrogen, and we have to feed them artificial forms of nitrogenous food.

In the normal course of events these *Rhizobium* bacteria live in the soil, obtaining their plant-foods, including nitrogen, from the soil. When the seed of a legume germinates in their vicinity these minute bacteria attach themselves to the very fine hairs on the young rootlets and work their way into the roots. Here they commence to multiply greatly in numbers, stimulate the plant to produce the galls or nodules, and the work of nitrogen fixation proceeds. After the crop has been harvested or ploughed in the nodules break up and decay and the bacteria are distributed into the soil again, where they can continue to live for considerable periods (sometimes years) and await the growing of another suitable legume.

It will readily be seen that if the land has never grown legumes before, or over a long period, there may be none of this type of bacterium left in the soil; in such a case, of course, there will be no nodules formed, no atmospheric nitrogen fixed, and the plant will have to depend on the nitrogen supplies of the soil. Even when the necessary bacteria are present, if there should be a high reserve of nitrates present in the soil, this will depress or prevent the activities of the bacteria, and there will be little or no gall formation and nitrogen fixation; in such a case the ploughing in of the green manure crop would merely result in returning to the soil the nitrogen which had been taken out by the crop, and would not increase the nitrogen stocks one little bit. Obviously, then, the time for the planting of a green-manure crop (as distinct from a mere cover crop) is when the nitrate stocks are low—but more of this later.

Up to the present we have spoken as though there were just a single species of this *Rhizobium* or nitrogen-fixing bacterium. Actually there are a large number of strains, which are each limited in their activities to certain plants or groups of plants. It has been found that

there are a certain number of so-called "cross-inoculation" groups of plants, and any one *Rhizobium* can only work in association with plants within one particular group. For instance, the cowpea, poona pea, velvet bean, and lima bean lie within one group, while lucerne, the sweet clovers, the trefoils, and melilotus constitute another group, and so on. Now, the *Rhizobium* species which forms nodules on the roots of the members of the first group, will not form them on members of the second group, and *vice versa.* Therefore the fact that land has grown an excellent crop of poona pea does not mean that it contains the right bacteria for the growth of, say, New Zealand Blue Lupin.

Fig. 35.—Roots of soybean plants showing nodules produced by nitrogen-fixing bacteria.

But not only do we have different groups of bacteria which will not work in association with other groups of leguminous plants, but there is a great variation in the efficiency of the strains within any one group. The meaning of this statement will best be illustrated by summarising some experiments with poona pea and soybeans, which were the right bacteria for the growth of, say, New Zealand blue lupin.

In view of what we believe to be the increasing importance of legume culture it was considered desirable to initiate some experimental work with a view to finding highly efficient strains of *Rhizobium* which could be used for the inoculation of crops at planting time. Consequently, cultures were collected from laboratories in various parts of the world, and, in addition, some cultures were isolated from the nodules of very well-grown Queensland crops.

Fig. 36.—Nitrogen-fixing bacteria taken from a root nodule. Magnified about 1,500 times.

In order to test the efficiency of the various strains the seeds are inoculated and then planted in sterilized sand which is free of plant-food. We use medium-sized earthenware pots, of the type exhibited, waterproofed to prevent evaporation. The plants are grown in a glass-house, and every care is taken to prevent contamination with bacteria which might blow in with dust. The plants are watered with a sterilized solution of plantfoods from which nitrogen is missing—that is to say, they are forced to get their nitrogen from the air.

Cultures for the Poona pea group were obtained from Western Australia, South Australia, Victoria, New South Wales, and Queensland, while soybean group cultures came from England, Canada, United States, and Australia. It is of interest to note that as far as these two crops are concerned the most efficient strains were isolated in Queensland from very well-grown crops at Cairns and Lawnton respectively.

In Fig. 37 will be seen a reproduction of Poona pea plants which were inoculated with a good strain (Cairns) and a medium strain (New South Wales) and the check uninoculated pot. Although these plants are young, it will be seen that the inoculation with the right strain has made a wonderful difference in growth—a difference which will become

more marked with increasing age. While the differences in actual growth are not so marked in the case of the soybean it will be seen (Fig. 38) that the smaller plants are also light in colour, showing nitrogen deficiency, while chemical analysis showed that the better strains produced a considerably higher nitrogen content.


Fig. 37.—Poona pea plants grown in sterilized sand. No. 7 inoculated with a good strain of nitrogen-fixing bacteria. No. 8 medium strain, No. 9 not inoculated.

We would also direct attention to the formation and distribution of nodules in both Poona pea and soybeans. In the case of the highly efficient strains the nodules are concentrated around the crown of the plant, while with the less effective strains the nodules may be equally or more numerous, but they are scattered through the root system. The roots of the uninoculated plants bear no nodules, and neither did the roots of a Poona pea plant which was inoculated with a strain specific to the New Zealand blue lupin.

So much, then, for the theory of green manuring; we will pass now to the consideration of a few points of field practice. We have seen that while legumes will grow in soils containing adequate nitrates they will also grow vigorously in nitrogen-starved soils provided they can make contact with an efficient strain of the proper species of nitrogen-fixing bacteria. For the full development of the plant it is not only necessary that the particular strain be present but that it be present in large numbers in order to ensure early and complete nodulation. When planting any legume, therefore, the wisest course to take would be to inoculate the seed with the appropriate culture immediately before planting. This is a very simple operation, and is now widely practised in the United States, where there are several commercial organisations which culture and sell inoculum for various crops. In Australia, both the Western Australian and New South Wales Departments of Agriculture sell for a nominal price cultures for the inoculation of seeds of


Fig. 38.—Soybean plants grown in sterilized sand. Nos. 5 and 4 were innoculated with nitrogen-fixing bacteria, while No. 10 was not inoculated. Note white sickly leaves of uninoculated plant.

some eight to ten groups of leguminous plants. It is proposed to continue our search for highly productive strains, and, on completion of this work, it will be possible for us to set up a similar service for Queensland cane farmers should they so desire it. Of course, the provision of the right strain of *Rhizobium* is only part of the story, and the crop will not grow if seed bed, moisture, and general plantfood balance are not right.

These nitrogen-fixing bacteria require that soils shall not be too acid, and they also like phosphates. Thus, farmers on land which requires liming (as tested by Bureau officers) should apply lime before planting, and a dressing of phosphate should be made where this plantfood is deficient.

However, one of the most important factors in the restriction of the activities of these bacteria is the presence of considerable amounts of nitrates in the soil. When there is sufficient nitrate present for the good growth of the plant without any nitrogen fixation taking place, the bacteria slow down on the job, and may form no nodules and actually become parasites of the plant. Under these conditions you may get an excellent crop, but it has only been a cover crop, and has not netted you the equivalent of a few hundredweight of sulphate of ammonia, which it should have done. Therefore, the right time to plant a green manure crop is when the nitrate supplies of the soil are low—that is, as soon as practicable after harvest, and while rotting of roots, trash, &c., is still going on.

Under the influence of moisture and warmth the organic matter of the soil is converted into nitrates by other forms of bacteria, and if a field is ploughed out and fallowed before or early in the rainy season there will usually be considerable nitrate reserves available by late autumn. If, then, a winter-growing legume is planted a good crop will result if weather conditions are favourable, but there will have been

little or no nitrogen fixation. Thus the crop will have been a cover crop but not a green manure crop in the strict sense of the term. Consequently, if only a single leguminous crop is to be grown, it should be planted before the old stubble and crop debris has had a chance to rot; if a second crop is to be planted, then it should be sown while the first crop is still in a state of decomposition.

Fig. 39.—Summer crop of *Crotolaria goreensis* grown on the Bundaberg Sugar Experiment Station.

Green manuring, then, should be done with one eye on the future, but with at least half an eye on the past history of the field.

## Wireworm Damage in Mackay.

### Forecast for 1938 Season.

Summer rainfall conditions in 1936 and 1937 were extremely favourable to the development of young wireworms of the "lowland" type, with the result that damage to newly planted fields was both widespread and severe; in many cases wholesale ploughing out and replanting was rendered necessary. Rainfall conditions during the current year have not been favourable, however, and it is confidently expected that wireworm damage to this season's plantings will be comparatively scarce and will be confined to very low-lying areas. Most of the "dips," hollows and lower ends of fields situated in the better type of river bank soils should be free of the pests, while moderately well improved forest country should yield satisfactory strikes unless some factor other than wireworms operates.

W. A. McD.

## Varietal Trial.

A varietal trial was set out on the farm of Mr. A. Grieve, Pine Creek, Bundaberg, with a view to determining whether P.O.J. 2714 is superior to P.O.J. 2878 under the local conditions.

Unfortunately, the crop suffered rather much from adverse growing conditions, and the yield results from the plant crop are therefore presented with reservations:—

| Variety. | Cane per Acre. | C.C.S in Cane. |
|---|---|---|
| | Tons. | Per cent. |
| P.O.J. 2714 .. .. .. .. .. .. .. | 11·9 | **14·0** |
| P.O.J. 2878 .. .. .. .. .. .. .. | **12·8** | 13·1 |

It will be observed that there is nothing decisive about the results. While P.O.J. 2878 gave a slightly higher tonnage per acre, the c.c.s. of P.O.J. 2714 was somewhat superior.

H.W.K.

# *The Progress of Mule Breeding at Fairymead.

By W. Grimes.

### Introduction.

MULES are being bred at Fairymead in order to conduct an experiment whereby a comparison can be made between the all-round efficiency of mules with that of Clydesdale horses. Clydesdales have been bred at Fairymead for many years and have been used extensively on all the active work associated with cane growing and harvesting.

### Breeding.

Two donkey sires were imported from Kansas, United States of America, in 1935, and these, together with selected Clydesdales mares, have been the foundation of the present mules. A class of active mares, about 15½ hands high and weighing between 1,300 and 1,400 lb., showing good quality, have been used.

### Progress to Date.

In 1936 thirteen mule foals were born, and were weaned in May, 1937, at an average age of six months. Since weaning they have had no special care—just feeding out on grass and lucerne in the paddock. They have been running out with Clydesdale foals of a similar age under rather severe climatic conditions. The rainfall during the later part of 1936 and most of 1937 has been sub-normal, and the grass and feed generally have been poor.

* Paper presented at the Bundaberg Conference, Q.S.S.C.T., February, 1938.

Fig. 40.—Illustrating the growth of the mules over a twelve-month period.

Fig. 40 illustrates the growth that has taken place in approximately thirteen months. The small mule is three weeks old and the larger mule fourteen months old. Fig. 41 gives a comparison of the growth and condition of the mules with those of a Clydesdale of a similar age.

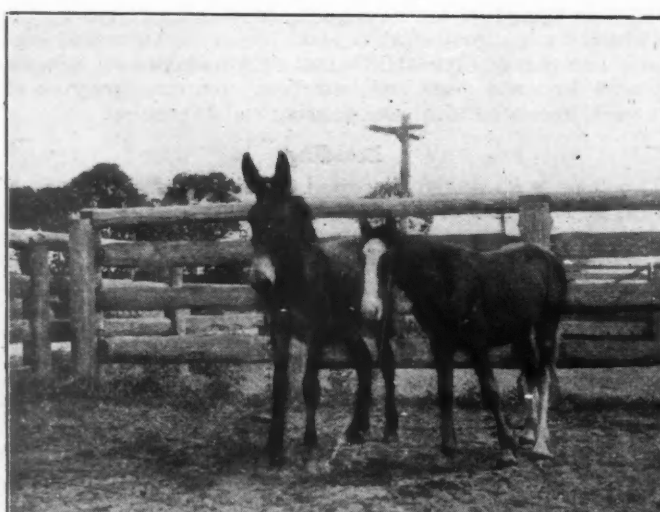


Fig. 41.—Show comparative growth of mule and Clydesdale yearlings

The condition and size of the Clydesdale foals give some idea of the severe conditions prevailing, whilst the condition of the mules speaks well for their ability to do well under severe conditions. Mules have always had a reputation as "good doers," and experience to date with them bears this out.

Apart from their general appearance their chief characteristics are their nimbleness and inquisitiveness. It is expected that they will be handled in the next few months and finally broken in as three-year-olds to work. When this occurs it will be possible to conclude as to their all-round suitability for work in the cane fields.

# The Problems of Arsenic Applications to Soil.

By R. W. Mungomery.

IN certain areas in Queensland there are some canegrowers who strongly advocate the application of white arsenic to the soil as a method of control for cane grubs. Now it is obvious that any method of soil treatment must be closely examined from two viewpoints, firstly, the immediate effect on the pest and, secondly, the permanent effect on the soil. As for the first point, it is a fact that the advocates of arsenic treatment have not been troubled with what can be regarded as heavy infestations of cane grubs while, in addition, their particular fields have usually been of a soil type which—due to its clayey nature—allows a small number of grubs to feed on the cane roots without the stool showing noticeable injury. That is to say, in their case, the degree of grub infestation usually fluctuates somewhere around the point where grub damage may or may not result.

Systematic diggings have shown that applications of white arsenic at the rate of 100-200 lb. per acre will kill some 60-70 per cent. of the grubs. Consequently if arsenic be applied under conditions of light to medium infestation it will reduce the grub population to numbers from which little or no damage will be sustained. Where, however, the grub population is such that the killing of some two-thirds will still leave sufficient grubs to cause appreciable damage it follows that arsenic treatment is ineffective as a method of control.

Added to such limitations is the question of costs. The arsenic must be applied to the field before it is known whether grub attack is probable or even possible. This arsenic must be applied to the whole of a field, whereas in practice it is often found that dangerous grub infestation is found to be restricted to a small portion of a field. The object of this note, however, is not to discuss costs but to draw attention to the second point mentioned above, namely, the effect of this treatment on the soil.

Some two and a-half years ago we had occasion to institute experiments with white arsenic applications to red schist soil at the Meringa Sugar Experiment Station, where small plots were treated with varying quantities of arsenic ranging from nil to 1000 lb. per acre. The arsenic

was applied to the surface of the soil and lightly hoed in. About a month later (December, 1935) sorghum was sown and an excellent germination was secured in all plots. The growth of sorghum in the different plots was very uneven, ranging from, say, very poor in the 1000 lb. plots to very good in the non-treated plots. Eight months later (August, 1936) the plots were planted with Badila cane, and again the growth of the crop was very variable; a definite stunting occurred in the 250 lb. plots, while only about half a crop was obtained from the 1000 lb. plots. After harvesting these plots the stools were dug out, and this experimental area was then included in the adjacent field, and the whole was planted to Badila in August, 1937. At the present time (January, 1938) the plots where arsenic was applied in 1935 still stand out clearly, the cane being much smaller and stooling less vigorously than in the non-treated plots.

Fig. 42.—Section of arsenic-treated plots at Meringa Station. The slow growth and small stooling of cane in the foreground (planted in August, 1937) shows the continued ill-effects of arsenic applied in 1935.

It is true that few, if any, farmers make applications of arsenic equal to the minimum of 250 lb. listed above, but nevertheless the continuous usage of even the lightest dressings as used by farmers will soon give an accumulated soil content greatly in excess of 250 lb. per acre. Under such conditions harmful effects must be expected, since arsenic is not dissolved out by rain and irrigation water but accumulates in the soil.

There is little doubt that crop damage as a result of arsenic accumulation is now commencing to become evident on certain farms in the Giru area. The cane is showing a yellow, unthrifty appearance long before grubs are present in the soil, and there is no doubt that sub-normal crops will result, at least for some years, whether grubs are present or not.

## Dwarf Disease in P.O.J. 2878 at Mackay.

Farmers in the Rosella area of the Mackay district will recall that some years ago some alarm was caused by an outbreak of an entirely new disease—Dwarf Disease. Fortunately, later experience showed that the disease remained restricted to low-lying farms or low-lying portions of farms in that area, and with the almost complete elimination of P.O.J. 2714 the disease virtually disappeared. Recently a few farmers in this "dwarf country" have tried plantings of P.O.J. 2878, but inspections carried out early this year have indicated that some of these crops have contracted dwarf. As a result farmers in this area are warned against making extensive plantings of P.O.J. 2878, and are urged to make no such plantings whatever in low-lying fields. The area has been very closely surveyed by Mr. McDougall, who should be consulted regarding proposals for planting P.O.J. 2714 or P.O.J. 2878 in this locality.

A.F.B.

## Selection of Planting Material in the Mulgrave Area.

Owing to the necessity for planting gumming resistant varieties to replace S.J. 4, farmers will to some extent be forced to go outside their own farms in order to obtain plants. In this connection it is well to sound a warning that a small amount of leaf-scald and downy mildew (or leaf stripe) exist in the district. Consequently, when deciding upon a source of supply of plants, great care should be taken to see that plants of susceptible varieties are not taken from the neighbourhood of these diseases.

The Java Wonder cane, P.O.J. 2878, shows marked susceptibility to downy mildew, as also do the other high numbered P.O.J. canes, with the exception of P.O.J. 2725.

The two gumming resistant varieties, Korpi and Oramboo, which are now being grown to some extent in the Mulgrave area, are rather susceptible to leaf scald, and in building up stocks of these two canes care should be taken to see that supplies are obtained from disease-free sources. This disease has been seen in several blocks of these two varieties in the Mulgrave district, and hence the need for greater care. As this disease is spread by the cane knife it follows that the cutting of only a few diseased stalks can infect a large number of future stools when cutting plants.

Farmers in doubt as to the suitability of particular fields are urged to get in touch with the Experiment Station at Meringa, or Mr. G. Bates, Instructor in Cane Culture, Cairns.

A.F.B.

## The New Seedling Q.2.

The following notes have been compiled for the guidance of North Queensland farmers, who will soon be commencing the 1938 planting programme.

A further year's experience with Q.2 has confirmed its promise of a vigorous plant crop with satisfactory sugar content if cut in the latter half of the season; it definitely is not an early-maturing cane. It has proved somewhat disappointing as a ratooner, and it should not be harvested early in the season, although when cut late some excellent ratoon crops have resulted.

For the guidance of farmers we have collected data on eleven experimental plots harvested in the far North. The time of harvest was recorded, and later the plots were inspected and the crops classified according as they appeared to be good, fair, poor, very poor, or a failure. For the purposes of enabling ready comparison we have constructed a graph (see Fig. 43) to show the relation between vigour of ratoon crop and time of harvesting. It will be seen that there is a gradual improvement in the ratoons as the harvesting is delayed, and these results strongly suggest that this operation should *not* be carried out before mid-September.

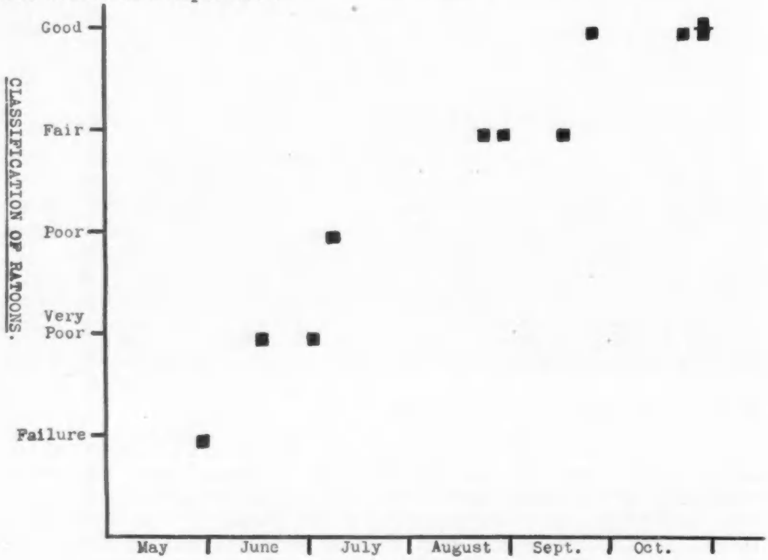



Fig. 43.—Showing that Q. 2 gives a good ratoon crop, if the plant cane is harvested after mid-September.

Several series of observations of flooded cane made in the Johnstone area by Mr. Knust indicate that this cane is considerably more "resistant" to flood damage than Badila. Doubtless this is mainly due to the fact that, Q.2 being considerably taller than Badila, the growing point is submerged for a shorter period of time than would be the case with Badila.

The previous season's indications of resistance to top rot and borer attack were again in evidence. G.B.

# *Further Notes on Spray Irrigation.

By H. W. KERR.

## INTRODUCTION.

THE subject of spray irrigation for cane has been brought before this Society on a previous occasion, when an experimental system installed by the Bureau of Sugar Experiment Stations was described. A new type of sprinkler was later described, and the officers of the Bureau have constantly been on the watch for a spray system which could be regarded as suitable for the cane farmer, while being free from the objection of high installation cost or high working pressure; both of these factors have operated against the systems hitherto discussed.

The notes here presented represent an attempt to keep this subject before growers on irrigated lands, in the hope that it may be possible to devise a scheme which would be practicable, or adaptable to Queensland conditions. Flood (or furrow) irrigation has been the standard practice of the canegrower, but it is fully appreciated that certain shortcomings attend this method, notably its unsuitability for broken country, or very sandy soils, while the unavailability of skilled field hands for this duty, particularly when watering is performed but intermittently, is no small problem in itself.

During recent months the writer has learned of the development both of new sprays and modified methods of application of water, and these will be described and discussed briefly.

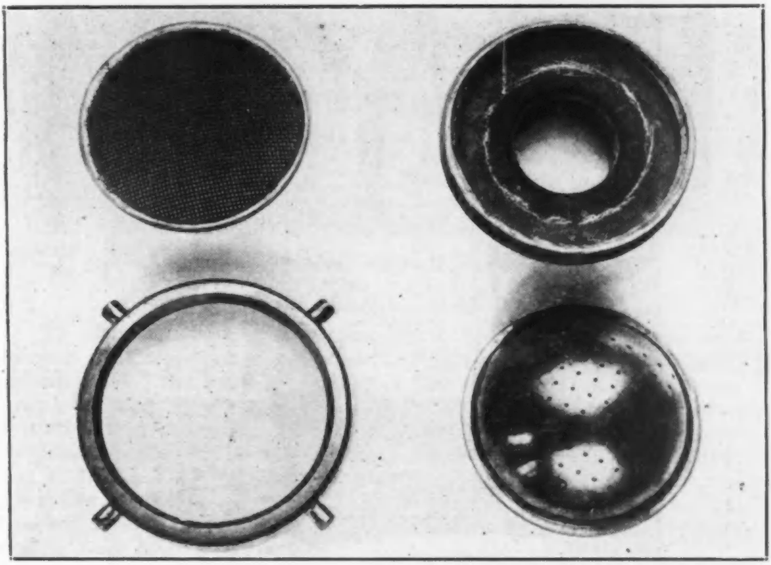


Fig. 44.—Illustrating the separate parts of the spray described.

* Paper presented at the Bundaberg Conference, Q.S.S.C.T., 25th February, 1938.

## NEW SPRAY NOZZLE.

In Figs. 44 and 45 is illustrated a spray nozzle which appears to possess some definite advantages over similar low-pressure devices. The major features of the spray are the accompanying strainer, to eliminate most of the dangers of chokage, and the disposition of the holes on a hemispherical distributor to provide even watering over a *square* plot, instead of the customary circle. The holes have been drilled in such a manner that the outer rows deliver more than those more centrally placed, and an even distribution results. Fig. 46 illustrates the spray in action.

The operating nozzle pressure is 15 lb. per square inch, and at this pressure the volume of water delivered may be varied by selecting the appropriate distributor. The distributors are made in three grades, as follows:—

| | Application per hour (acre-inches) |
|---|---|
| 8 rows of 8 holes .. .. .. .. .. | 1·00 |
| 9 „ „ 9 „ .. .. .. .. .. | 1·26 |
| 10 „ „ 10 „ .. .. .. .. .. | 1·56 |

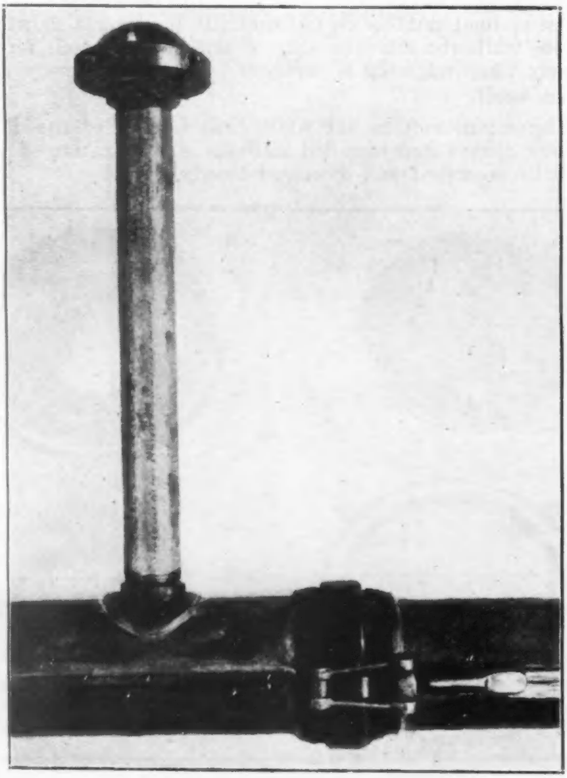


Fig. 45.—Showing the assembled spray and short standpipe attached to clip-jointed fluming.

The coverage of each spray is a square of 35 feet side, when attached to a standpipe 1 foot high. This necessitates about thirty-six sprays to cover an area of 1 acre at a time.

With a crop such as cane it would be necessary to place the spray on a standpipe of greater height than that suitable for, say, lucerne. The increased height would give substantially greater coverage for the spray, but also adds to the difficulty of transportation if a portable system is desired. In certain areas of Queensland where farmers are desirous of irrigating only during the (normally) dry spring and early summer, it would be possible to use a 6-foot standpipe, and this should not introduce any trouble during transportation.

The adaptation of the height of standpipe to stage of development of the crop could also be considered. It would be neither very costly nor troublesome to employ, say, 3-foot standpipes for young cane and 6-foot pipes when the height of the cane demands it.

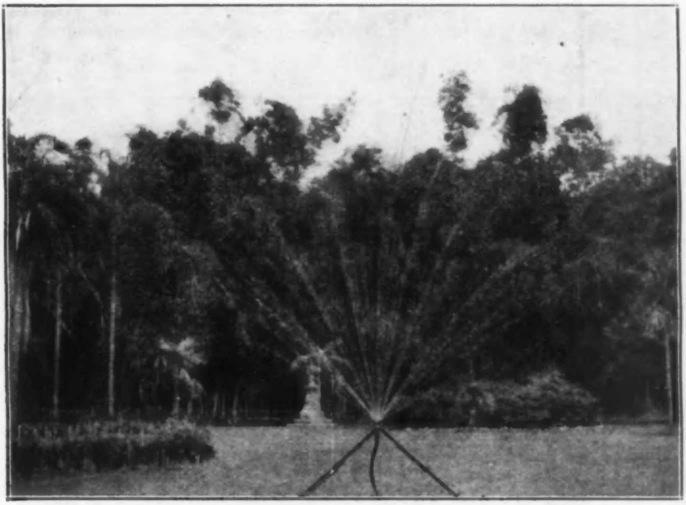


Fig. 46.—The spray operating at 15 lb. nozzle pressure.

## SUITABLE LAYOUT.

To illustrate how such a spray system could be employed as a portable unit, a layout will be described in which a particular enquiry is dealt with. The grower in question has an area of sandy loam soil, approximately 20 chains in width, and divided into two almost equal parts by a permanent creek which runs through the length of the farm. By damming the creek, it would be possible to bring the water within, say, 8 feet of the level of the fields, which are virtually flat. A schematic layout which would involve the use of a tractor, with pump attached, is shown in Fig. 47, for which the following description applies:—

By means of a flexible hose, the water is drawn from the creek, through a footvalve and strainer, and forced by the centrifugal pump through, say, three lines of sprays, set at intervals of 35 feet, for use

with the unit already described. The field is 10 chains in length, and each spray line would therefore require nineteen sprinklers. Each sprinkler (say, sixty-four-hole type) delivers about 10 gallons of water per minute, so that fifty-seven sprays, in three lines, will distribute

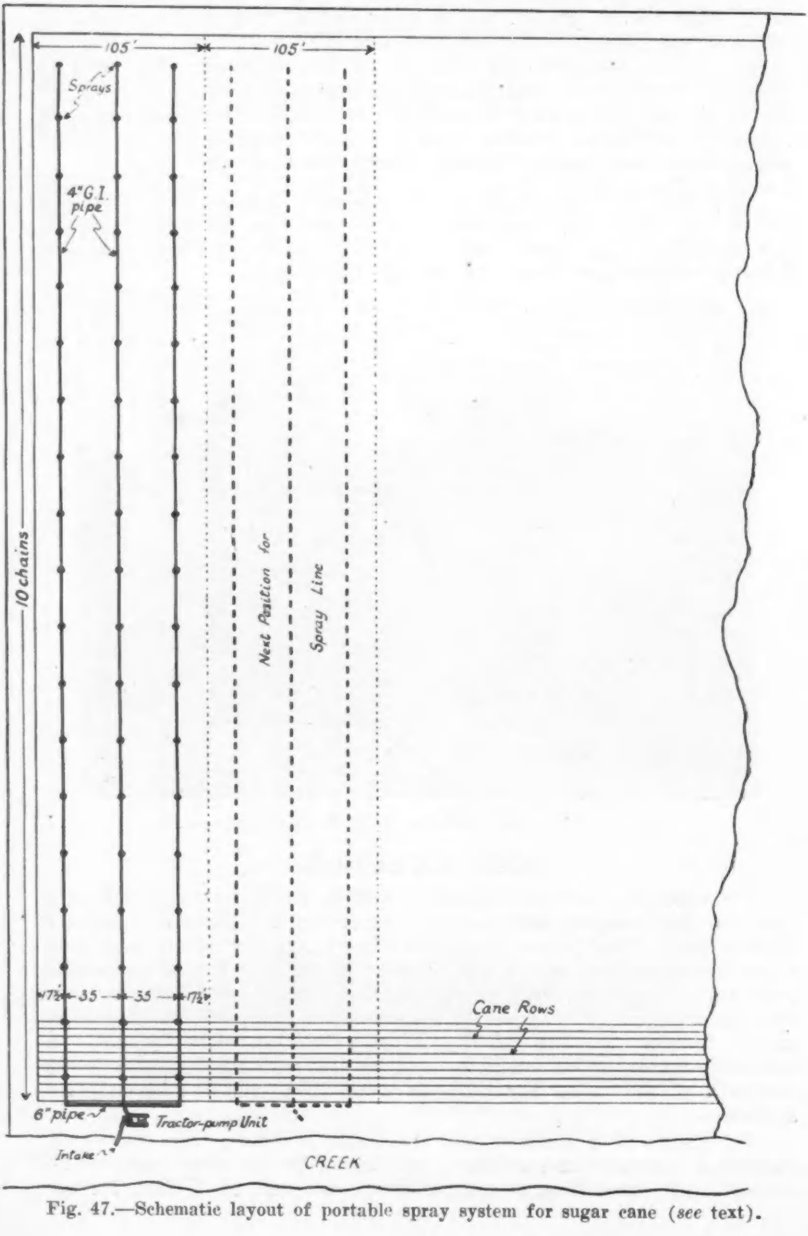



Fig. 47.—Schematic layout of portable spray system for sugar cane (*see* text).

approximately 35,000 gallons of water per hour. This quantity would be delivered by a 5-inch pump. The headland main fluming could be 5 or 6 inches in diameter, while for the three laterals 4-inch round fluming would suffice.

The total head against which the pump would operate, with the above layout, would be approximately 70 feet, and the power required, 20 b.h.p. By employing 5-inch fluming for one-third the length of laterals, friction losses would be minimised, and the power required reduced by about 15 per cent. Such a layout (Fig. 47) would apply 3 acre-inches to 1·6 acres in 3 hours, when the system would be uncoupled and transferred 105 feet across the field. By using clip-jointed fluming (*see* Figs. 45 and 48), fitted with compression rubber rings, this would present no difficulty with the lateral fluming. The tractor could be employed, if desired, to transport the four 17-foot 6-inch lengths of larger main, as well as the flexible hose coupling and intake pipe, when moving to its new position. Assuming that three strips (or 4·7 acres) can be sprayed in a 12-hour day, the system could take care of 47 acres where fortnightly waterings are desired.

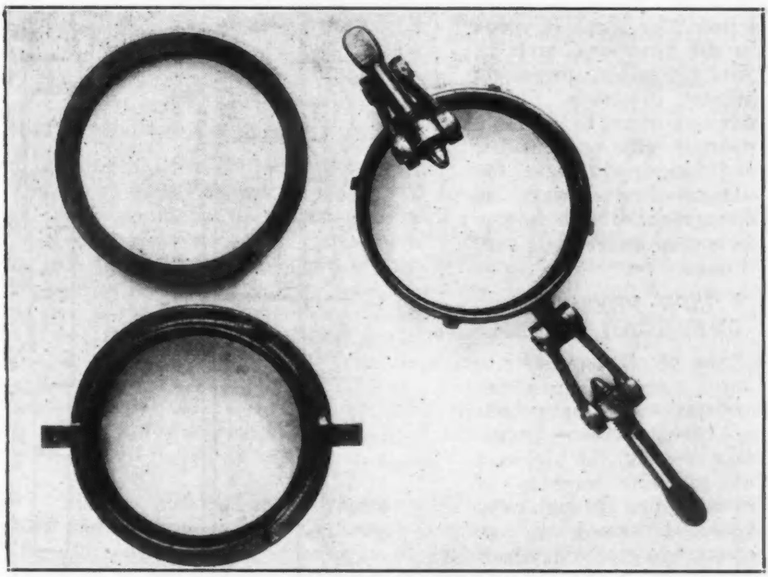


Fig. 48.—Illustrating the separate units used in an effective clip-joint for fluming.

The cost of the complete distribution unit (but *excluding* tractor and pump) would be about £200. Care should be taken to obtain heavy gauge fluming (say, 22 gauge) and, before use, protect it with a coating of tar or similar preparation if it is to be employed with water of a corrosive nature.

## SOUTH AFRICAN SPRAY SYSTEM.

Recently we read of a new system of spray irrigation which has been developed for cane in South Africa. Although further details were sought, these have not been received to date; but it would appear that a tractor-pump unit is employed, operating on the headland and drawing water from a ditch which is supplied by gravitation from the neighbouring hills. The pump forces the water through a nozzle, mounted on an elevated platform, and it is claimed that the water is distributed "for about 70 yards in all directions, and, in windy weather, for much greater distances." The device appears to possess a definite value on hillsides, as it largely eliminates the danger of washaways, as are associated with furrow irrigation under these conditions.

## LOW PRESSURE OVERHEAD SYSTEM.

The chief drawbacks to most overhead spray systems which have been advanced for cane irrigation are—(*a*) the high cost of pipe-line capable of withstanding the high pressures developed, in an attempt to give wide coverage to each spray, and (*b*) the increased pumping costs involved due to the nozzle pressure required.

The writer recently inspected a model of an overhead distribution system which, it is claimed, will effectively overcome

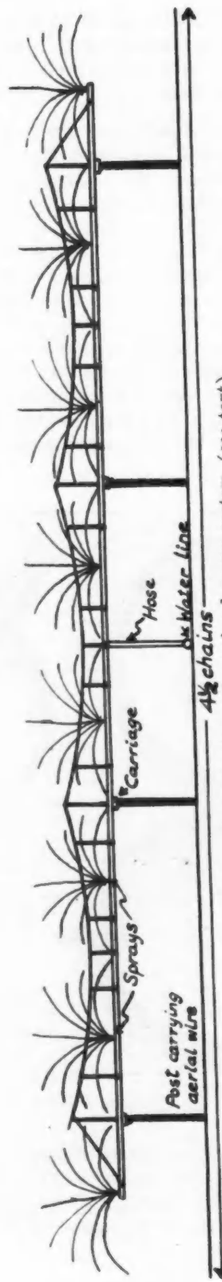



Fig 49.—End elevation of overhead spray system (*see* text).


Fig. 50.—Illustrating how the weight of the distributor and load could be minimised by a progressive reduction in diameter of pipe.

these drawbacks. The unit consists essentially (Fig. 49) of a pipe-line (up to 4 or 5 chains in length), mounted on simple carriages, with grooved wheels, to allow the pipe-line to be drawn across the field on heavy gauge overhead wires. It is proposed that one tightly-stretched wire per chain of distribution line will be adequate. The pipe-line would be fitted with suitable sprays, and that already described (*see* Figs. 44 and 46) should be quite satisfactory. The distribution unit would be supplied with water from a centrally placed pipe-line, laid on the ground and running the length of the field. This would deliver the water under the necessary pressure by means of a flexible connection to the distributing unit.

Certainly such a system is decidedly unique in character, but it does possess some definite advantages, if it should prove to be practical. It would be necessary to construct this distributor rigidly but lightly, and 22-gauge galvanized iron could be used. To ensure a minimum of water load, consistent with ample dimensions to eliminate undue friction losses, progressive reduction in diameter of pipe (*see* Fig. 50) would be desirable. Such a distributor would hold about 50 gallons of water, and the total load on each wire should not exceed 200 lb. The length of aerial wire (10 chains) would demand a number of intermediate supports, to avoid the undue tension which would be necessary to keep the wire taut. Most of these supports need be only temporary, and these could be moved to a new position each time the position of the distributor is altered. The even movement of the carriages over the wires might give some trouble, unless two suitably spaced cables attached to one windlass be employed.

Perhaps a better plan would be to support the distributor on 14 lb. (portable) rails, instead of wires. To equip the field permanently in this way would be, of course, prohibitive; but if three lengths (each 35 feet long) were available in place of each wire, it would be possible to transport one to its new position while the distributor rested on the remaining pair. Permanent posts to carry the rails would, however, be necessary; on the other hand, it should be possible to make two, or at most three, rails do the work of four wires. Double-flanged wheels for the carriages should then eliminate possible difficulties in the regular and even movement of the distributor. It is evident that such a system would require very accurate installation, in respect of distance between wires (or rails) and care to ensure even distribution of the load over all wires. Topographical irregularities would introduce difficulties also.

The patentee claims that the carriages could be kept in continuous slow motion, while watering, by employing a sufficient length of flexible hose to connect the distributor to the pipe line. Detachment of the hose and re-connection at a new point in the line could be made at intervals of 100 feet, thus requiring about 45 feet of hose. It is felt that the cost of the 4-inch hose required, and difficulties for the distributor in "dragging" this with its load of water, could best be avoided by having direct connecting points at 35 feet intervals, and changing the position of the distributor intermittently, say, every 3 hours, where a 3 acre-inch application is desired.

It will be noted that the layout described and illustrated would water only 4½ acres, with fields 10 chains in length; to water the adjacent

strip of $4\frac{1}{2}$ acres, it would be necessary either to transport the distributor to a new series of aerial wires, or have a separate unit for each strip of the field. Transportation of the empty unit should not prove a difficult matter, particularly if built for rapid dissembling.

It should be stressed that the writer has not seen this ingenious device operating under field conditions, and no data are available for actual installation costs. Such posts and supports as are necessary for the aerial could probably be found on or near the farm, and installed by the farmer. Aerial wire of 6-gauge would cost about £2 for 9 chains—the amount required per acre on the layout described. Portable rails would, of course, be more costly; twelve 35-foot lengths (using four lines to carry the distributor) would cost about £15. These would be sufficient for the entire area served by one distributor, so that the cost *per acre* would be little more than for the wire.

If the pipe-line feeding the distributor were of galvanized wrought iron pipes, laid permanently, the cost would be excessive. But by employing portable 4-inch clip-jointed fluming, of 22-gauge galvanized iron, the system would be cheapened very considerably. The cost of 10 chains of 4-inch fluming would be approximately £50.

On the proposed plan (Fig. 49) eight sprays would deliver about 5,000 gallons per hour, thus requiring but a small pump (say 2-inch), driven by a 4 h.p. engine. An irrigation of 3 acre-inches could be applied to nearly 1 acre per 12-hour day. For a large area it would therefore be necessary to install, say, four such units, fed by a portable main pipe-line of greater diameter (7 inches) laid on the headland. By this means it would be possible to operate three units at a time (while the fourth is being set up in its new position), and an area of 30 acres could be watered per fortnight. A substantial increase in area covered could also be effected by using the nozzle which applies $1\frac{1}{2}$ acre-inches per hour, and/or by operating for a longer period each day.

### CONCLUSION.

It is hoped that the sketchy details presented will stimulate further thought on the subject of spray irrigation. Any system will necessarily require adaptation to meet local conditions; the question is not a simple one, but the inventive mind of our canegrowers, who have solved so many cultivation and other farming problems in the past, should ultimately result in the evolution of a system which will prove both effective and economical.

## The Use of Concrete in Farm Buildings.

The general use of concrete in all manner of modern structures suggests that this material might be used to even greater advantage on the farm than is the case at present.

In addition to its high degree of permanence and low maintenance cost, it offers other distinct advantages not shared by timber or iron buildings. For tropical conditions a cavity-wall concrete building provides a degree of personal comfort in hot weather which no single-walled structure as instanced can give. The accompanying photographs

Fig. 51.—Illustrating the construction of barracks with pre-cast cavity blocks.

(Figs. 51 and 52) illustrate the use of pre-cast cavity concrete blocks in the construction of farm barracks and cookhouse. These were erected on a farm in the Burdekin area, where a readily available supply of sand and gravel were at hand. The farmer claims that these buildings cost little more to erect than the standard barracks.

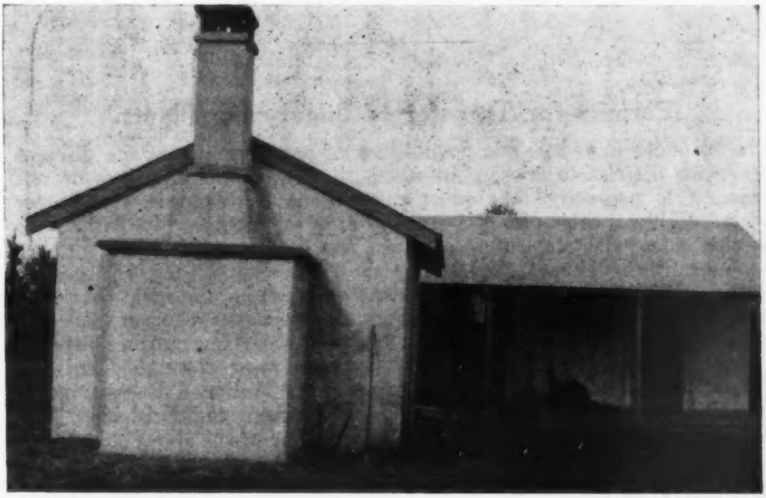


Fig. 52.—Another view of the barracks and cookhouse constructed of concrete.

Full constructional details will be supplied to any canegrower interested in the subject.

H.W.K.

## Variety P.O.J. 2878 and Downy Mildew Disease.

With its many virtues, the Java Wonder cane (P.O.J. 2878) possesses two very distinct weaknesses—susceptibility to Fiji and downy mildew diseases. Although these were relatively unimportant diseases in Queensland a few years ago, they assume quite a different aspect in the Bundaberg and Mackay areas with the continued planting of a susceptible variety.

Our recent inspections of certain parts of the Mackay district show that a high proportion of the fields of this variety carry downy mildew disease. The widespread character of the disease has therefore necesitated the removal of the cane from the variety lists supplied to local boards this year in the Farleigh, Racecourse, Pleystowe, and Marian mill areas, with the exception of those lands lying north of The Leap.

This precaution has been taken in the interests of other susceptible canes now grown as major varieties. With a continuance of plantings of diseased P.O.J. 2878, the situation could become very serious.

Though the cane has been retained in the lists for North Eton, Cattle Creek, and Plane Creek, similar action will be taken should the disease be found subsequently in these areas. Growers should remember that P.O.J. 2714 is also susceptible to the disease, though P.O.J. 2725 is resistant.

It is felt that, with the full co-operation of all growers in reporting the existence of the disease on their farms, the district could be rid of this trouble, and P.O.J. 2878 re-introduced in a few years' time in a healthy condition.

H.W.K.

## Permits for Transfer of Sugar-cane Plants.

In order to reduce the possibilities of carrying sugar-cane diseases from one district to another in which those particular diseases do not exist, it is necessary that strict precautions be taken in the matter of transferring cane plants from one area to another. In futherance of this object the State of Queensland has been divided into a number of quarantine districts, and under the provisions of the Diseases in Plants Acts the transport of sugar-cane plants from one such district to any other is prohibited unless a permit has been issued by an inspector under the Acts. The boundaries between these quarantine districts consist of imaginary lines drawn east and west through Cardwell, Townsville, Bowen, Alligator Creek (south of Mackay), Rockhampton, Burrum, the southern end of Great Sandy Island, and Brisbane. Any person desirous of sending cane plants across any of the above boundaries at any time during the current season, should make an early request for the necessary permit, to the Director, Bureau of Sugar Experiment Stations, Brisbane.

David Whyte, Government Printer, Brisbane.